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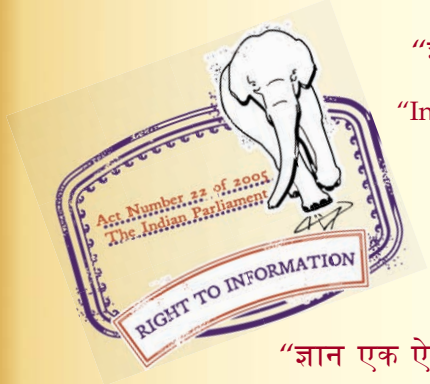

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PART 8 RESISTANCE TO CRACK-GROWTH

(First Revision)

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Indian Standard

METHODS OF TEST FOR VULCANIZED RUBBERS

PART 8 RESISTANCE TO CRACK-GROWTH

(First Revision)

0. FOREWORD

0.1 This Indian Standard (Part 8) (First Revision) was adopted by the Indian Standards Institution on 10 November 1983, after the draft finalized by the Rubber Products Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

0.2 This standard was first published in 1967 and is now being revised to align it with ISO 133-1981 Rubbers, vulcanized — Determination of crack growth (De Mattia), published by the International Organization for Standardization.

0.3 This method of test is intended for comparing the resistance of vulcanized rubbers to crack-growth when crack is initiated and is subjected to repeated bending or flexing. Repeated bending or flexing of a rubber vulcanizate causes this initiated crack to extend in a direction perpendicular to the stress.

0.4 The tests described here are intended for use in comparing the resistance of rubbers to the formation and growth of cracks. The relative magnitudes of the two resistances, (a) resistance to crack initiation, and (b) resistance to crack-growth, differ in different rubbers. It is, therefore, imperative that both the resistance to crack initiation and the resistance to crack-growth be measured. A method for determining the resistance to flex-cracking is prescribed in IS : 3400 (Part 7)-1967*.

0.5 The variation between the results obtained for resistance to crack-growth with nominally identical test pieces increases as the period of testing is prolonged, the variation being approximately proportional to the period of flexing with a coefficient of variation of 30 to 60 percent. The mean of the results obtained on six test pieces has a coefficient of variation of 12 to 24 percent.

*Methods of test for vulcanized rubbers : Part 7 Resistance to flex-cracking.

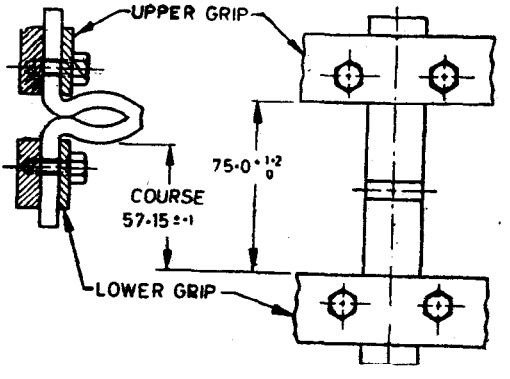
0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960* The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part 8) specifies a method of test intended for use in comparing the resistance of rubbers to the growth or cracks, when subjected to repeated flexing on the De Mattia type machine. For this purpose, a prescribed cut is made in the test piece to initiate cut growth.

2. APPARATUS

2.1 The essential features of the De Mattia type machine are shown in Fig. 1.



All dimensions in millimetres.

FIG. 1 DE MATTIA TYPE MACHINE

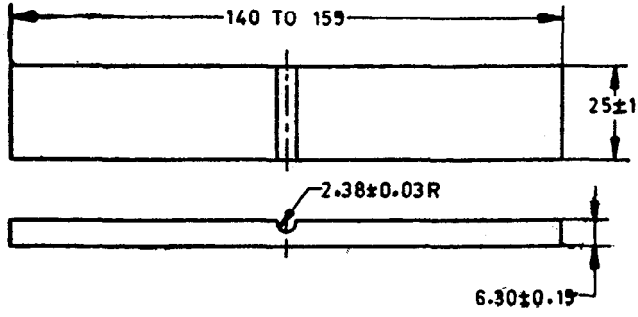
*Rules for rounding off numerical values (*revised*).

2.2 There shall be stationary parts, provided with grips for holding one end of each of the test pieces in a fixed position, and similar but reciprocating parts for holding the other ends of each of the test pieces. The travel of the reciprocating parts shall be 57·15 ± 0·10 mm and such that the maximum distance between each set of opposing grips is $75{\cdot}0^{+1{\cdot}2}_{-0{\cdot}0}$ mm. The reciprocating parts shall be so arranged that their motion is in the direction of and in the same plane as the common centre lines of each opposing pair of grips. The planes of the gripping surfaces of each opposing pair of grips shall remain parallel throughout the motion. The eccentric which actuates the reciprocating parts shall be driven by a constant speed motor to give 300 ± 10 flexing cycles per minute, with sufficient power to flex at least 6, and preferably 12, test pieces in one test. The grips shall hold the test pieces firmly without undue compression and shall enable individual adjustment to be made to the test pieces to ensure accurate insertion. The test pieces shall be arranged in groups of three or six so that one group is being flexed while the other group is being straightened, thus reducing the vibration in the machine.

2.3 For testing at elevated temperatures, the machine may be enclosed in a chamber with temperature controlled to ± 2°C, if necessary, be using an air-circulator, the temperature to be recorded near the centre of the test pieces.

3. TEST PIECE

3.1 The test piece shall be a strip 25 mm wide with a moulded groove as shown in Fig. 2. The strips may be moulded individually in a multiple cavity mould or may be cut from a wide slab having a moulded groove. The moulded groove shall be perpendicular to the grain direction. The groove in the test piece shall have a smooth surface and be free from irregularities from which cracks may start prematurely. The groove shall be moulded into the test piece of slab by a half round rigde in the centre of the cavity, the ridge having a radius of 2·38± 0·03 mm. The results shall be compared only between test pieces having thicknesses agreeing within 0·13 mm when measured close to the groove because the results of the tests are depenent upon the thickness of the test piece.



All dimensions in millimetres.

FIG. 2 TEST PIECE

3.2 At least three, or preferably six, test pieces from each rubber shall be tested and the results averaged, one or more test pieces being tested simultaneously with those of other rubbers with which the comparison is to be made.

3.3 **Preparation of the Test Piece** — Each test piece shall be prepared by piercing the bottom of the groove at a point equidistant from the sides, using a jig. The piercing tool shall be maintained perpendicular to both the transverse and longitudinal axes. The cut shall be parallel and centred to the longitudinal axis of the groove and accomplished by a single insertion and withdrawal of the tool. Soap water may be used as lubricant.

3.3.1 Although it is not necessary to include exact details of a suitable jig for holding the cutting tool, it may be useful to state the basic principles covering the design of such a jig. The test piece shall be held flat on a solid support; the cutting tool shall be normal to the support and placed centrally with respect to the groove of the test piece, with the edge of the chisel parallel to the axis of the groove. Means shall be provided for passing the cutting tool through the entire thickness of the rubber and the support shall have a hole of a size just sufficient to permit the cutting tool to project through the base of the test piece to a minimum distance of 3 mm.

3.3.2 The piercing tool shall conform to the dimensions given in Fig. 3.

4. TIME LAPSE BETWEEN VULCANIZATION AND TESTING

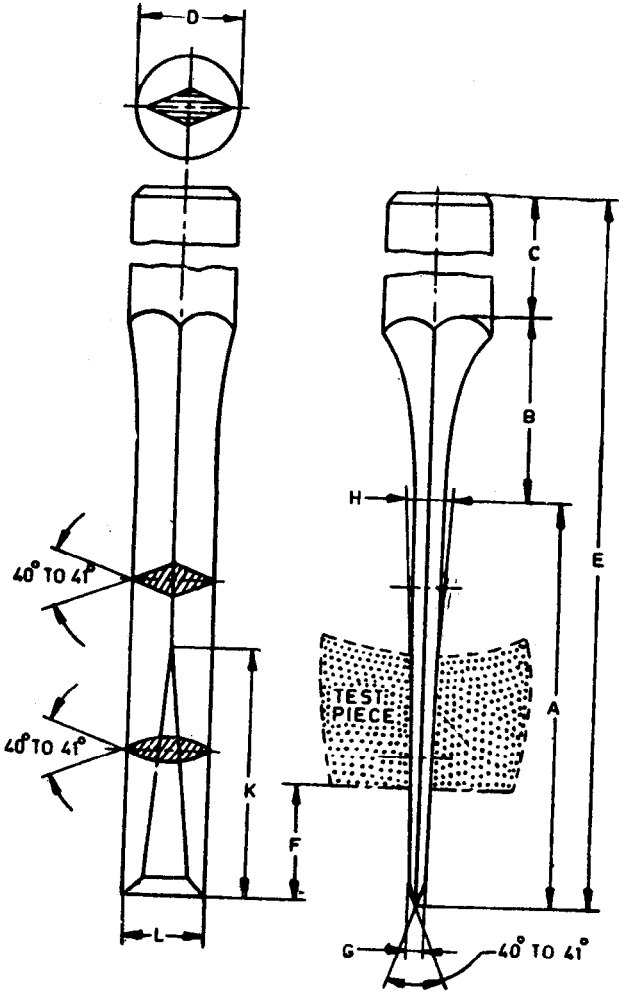
4.1 For all test purposes the minimum time between manufacture and testing shall be 16 hours, in order to ensure that the material attains dimensional stability due to stress relaxation.

4.2 In order to bind the user and supplier to a stipulated time for carrying out conformity test for supplied material, the following shall apply.

4.2.1 For non-product test separate test piece is required for testing. Therefore, the maximum time between manufacture and testing shall be 8 weeks and for evaluation intended to be comparable, the tests as far as possible should be carried out after the same time interval.

4.2.2 For product test whenever possible the time between manufacture and testing should not exceed 4 months. In other cases tests shall be made within 2 months of the date of the receipt of the product by the customer.

4.3 Protect sample and test pieces from light as completely as possible during the interval between vulcanization and testing.



DIMENSION	mm
A	10
B	4
C	45
D	2·6
E	54
F	2·5 to 3·0
G	$0{\cdot}3\ ^{+0{\cdot}05}_{-0}$
H	1·0
K	6
L	$2{\cdot}03\ ^{+0{\cdot}05}_{-0}$

FIG. 3 PIERCING TOOL

4.4 Conditioning — For tests at standard laboratory temperatures (*see* **5.1**) individually moulded test pieces, after preparation as necessary, shall be conditioned at the test temperature for a minimum 3 hours immediately before testing. The same temperature shall be used throughout any test or series of tests intended to be comparable. Slab samples shall be similarly conditioned before the test pieces are cut. These test pieces may be either tested immediately or kept at the test temperature until tested.

For tests at elevated temperature; after the conditioning period specified above, the test pieces shall be brought to the test temperature by keeping in a chamber at this temperature for 3 hours and then tested immediately.

5. TEMPERATURE OF TEST

5.1 Tests are normally performed at standard laboratory temperature, namely 27 $\pm$ 2°C, although elevated temperatures may often be used with advantage. In the later case the test temperature shall be one of the perferred temperatures, namely, 40, 50, 70, 85, 100, 125 or 150°C.

6. PROCEDURE

6.1 Separate the pairs to their maximum extent and insert the test pieces so that they are flat and not under tension, with the groove in any particular test piece midway between the two grips in which the test piece is held and on the outside of the angle made by the test piece when it is bent.

6.2 Stop the machine at frequent intervals to measure the length of the crack, for example, at 1, 3 and 5 kilocycle periods and at such further or intermediate periods, as appears necessary. At each observation separate the grips by a distance of 65 mm and measure the crack preferably by using a low power microscope.

7. EXPRESSION OF RESULTS

7.1 A smooth curve shall be drawn by plotting length against number of flexing cycles and the readings shall be taken for the following:

a) The number of kilocycles for the crack to extend from 2 to 4 mm (100 percent crack-growth);

b) The number of kilocycles for the crack to extend from 4 to 8 mm (300 percent crack-growth); and

c) If desired, the number of kilocycles for the crack to extend from 8 to 12 mm (600 percent crack-growth).

8. REPORT

8.1 The report shall state:

a) the number of kilocycles for the crack to extend from 2 to 4 mm (100 percent crack-growth);

b) the number of kilocycles for the crack to extend from 4 to 8 mm (300 percent crack-growth);

c) if desired, the number of kilocycles for the crack to extend from 8 to 12 mm (600 percent crack-growth);

d) the number of test pieces; and

e) the temperature of the test.

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